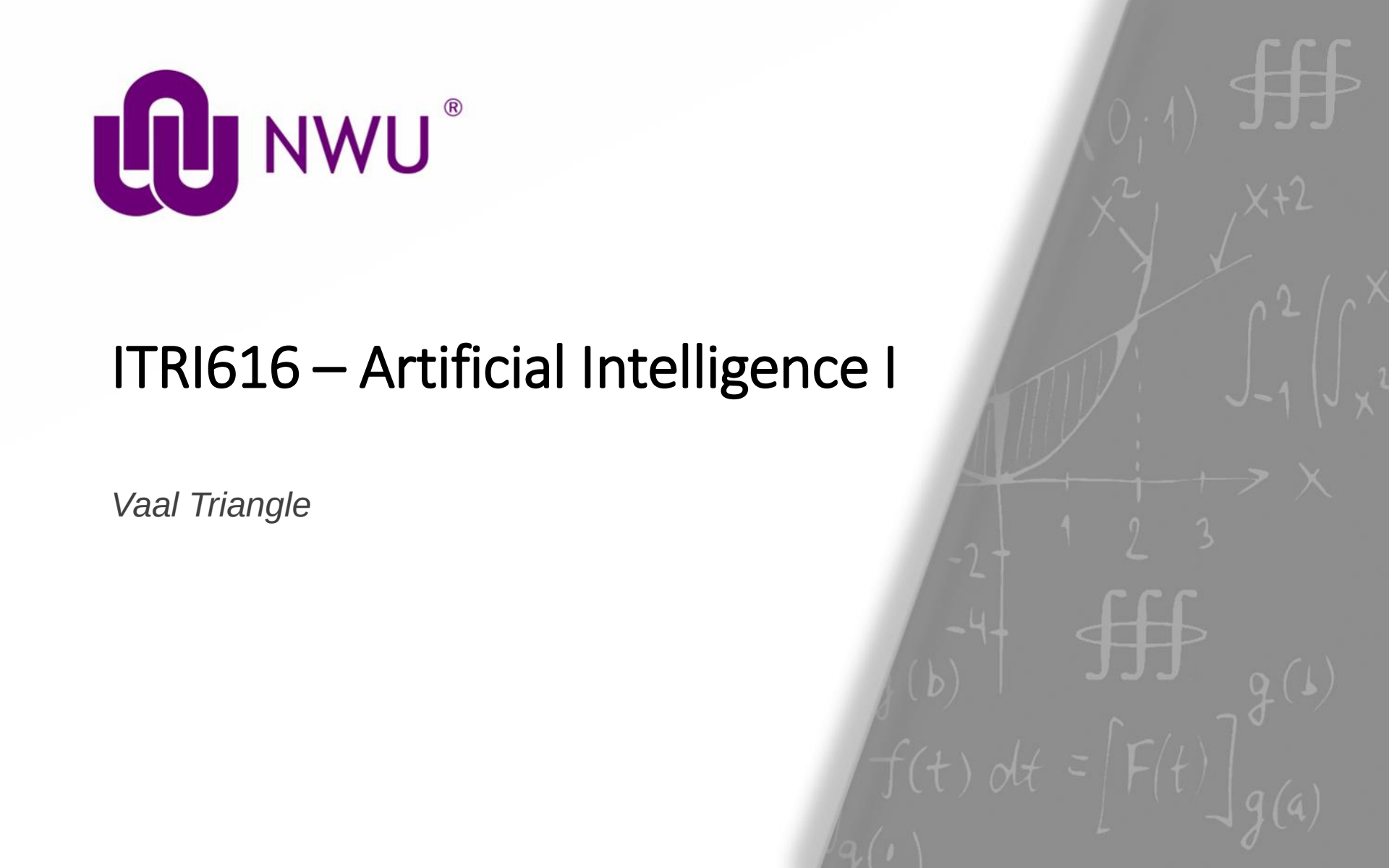


ITRI616 – Artificial Intelligence I

Vaal Triangle

Tonight

- Electronics
- Embedded engineering
- Further study in your own time…

Sources

- These are two of my favourite sources of knowledge in this area, and I would encourage you to watch both free lecture series if you would like to know more. I will draw a lot of knowledge from them for tonight's class
- **MIT OCW: Circuits and Electronics**

https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/

- **Crash Course Computer Science**

https://www.youtube.com/watch?v=tpIctyqH29Q&list=PL8dPuuaLjXtNlUrzyH5r6jN9ulIgZBpdo

Where does all this fit in

- In approaching the field of electronics, robotics and engineering as a whole, it helps to have some frame of reference to help you understand how things fit together, and why and how we do things.

Where does all this fit in

- In approaching the field of electronics, robotics and engineering as a whole, it helps to have some frame of reference to help you understand how things fit together, and why and how we do things.
- I would like however to start with a quotation that has meant a great deal to me in my life, and I may get a little choked up in reading it, but I think it is important to have something like this to give you direction in your professional life

An Engineer

"I take the vision which comes from dreams and apply the magic of science and mathematics, adding the heritage of my profession and my knowledge of nature's materials to create a design.

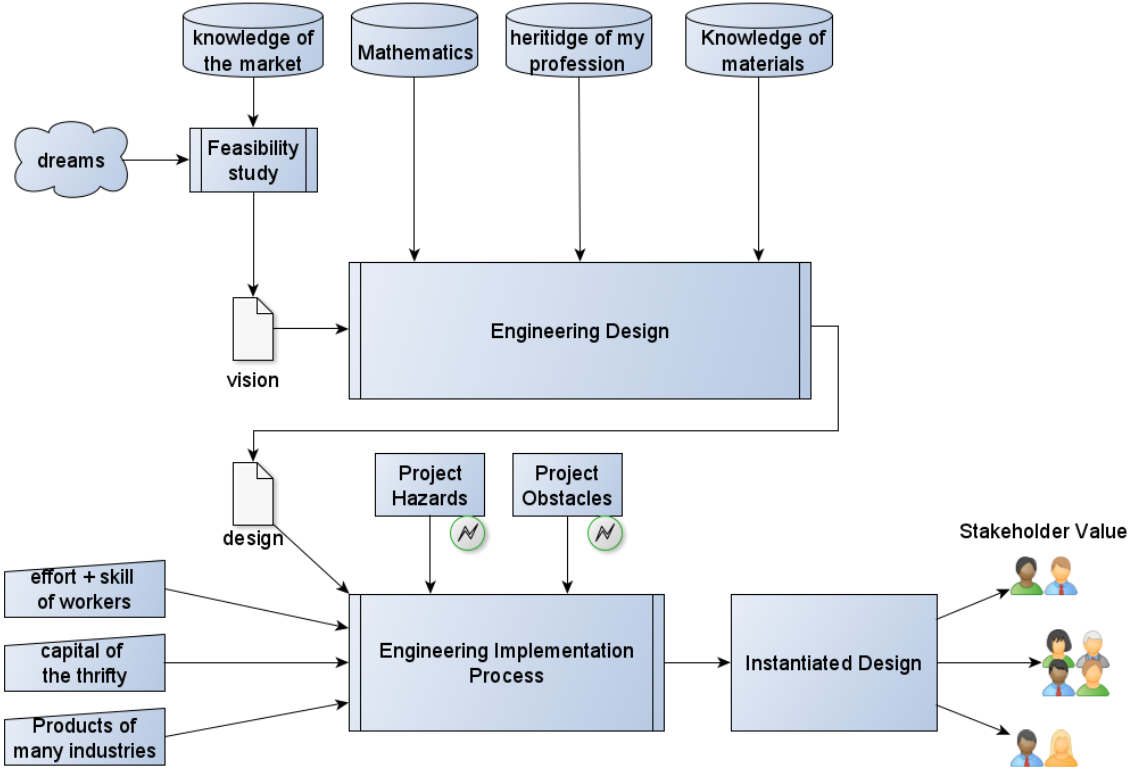
I organise the efforts and skills of my fellow workers, employing the capital of the thrifty and the products of many industries, and together we work toward our goal undaunted by hazards and obstacles.

And when we have completed our task all can see that the dreams and plans have materialised for the comfort and welfare of all.

I am an Engineer, I serve mankind, by making dreams come true.“

- Anonymous

An Engineer


knowledge of the market
Mathematics
heritidge of my profession
Knowledge of materials
dreams
Feasibility study
vision
Engineering Design
design
Project Hazards
Project Obstacles
Stakeholder Value
effort + skill of workers
capital of the thrifty
Products of many industries
Engineering Implementation Process
Instantiated Design

Where does all this fit in

- But where do you find all of this knowledge?
- Mathematics – MIT OCW, MOOCs

Where does all this fit in

- But where do you find all of this knowledge?
- Mathematics – MIT OCW, MOOCs
- Heritage of the Profession - MIT OCW, YouTube, MOOCs

Where does all this fit in

- But where do you find all of this knowledge?
- Mathematics – MIT OCW, MOOCs
- Heritage of the Profession – MIT OCW, YouTube, MOOCs
- Knowledge of Materials – MIT OCW, YouTube, MOOCs

Where does all this fit in

- But where do you find all of this knowledge?
- Mathematics – MIT OCW, MOOCs
- Heritage of the Profession – MIT OCW, YouTube, MOOCs
- Knowledge of Materials – MIT OCW, YouTube, MOOCs
- Effort and Skill of workers – **Network with your fellow students**

Where does all this fit in

- But where do you find all of this knowledge?
- Mathematics – MIT OCW, MOOCs
- Heritage of the Profession – MIT OCW, YouTube, MOOCs
- Knowledge of Materials – MIT OCW, YouTube, MOOCs
- Effort and Skill of workers – **Network with your fellow students**
- Capital of the Thrifty - https://smesouthafrica.co.za/investors-invest-south-africa-startups/

Where does all this fit in

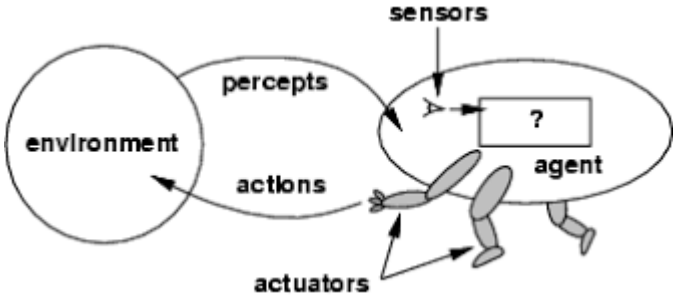
- But where do you find all of this knowledge?
- Mathematics – MIT OCW, MOOCs
- Heritage of the Profession – MIT OCW, YouTube, MOOCs
- Knowledge of Materials – MIT OCW, YouTube, MOOCs
- Effort and Skill of workers – **Network with your fellow students**
- Capital of the Thrifty - https://smesouthafrica.co.za/investors-invest-south-africa-startups/
- Products of many industries – **Local Source Research**

Tonight

- I would like to introduce you briefly to analog and digital systems and what we mean by these sorts of signal, and why we use them. We will look in some depth at the high level design of sensors, and what signals can be found where in a robotics design. Please feel free to ask many questions as I suspect some of this will take you out of your comfort zone…

Abstraction

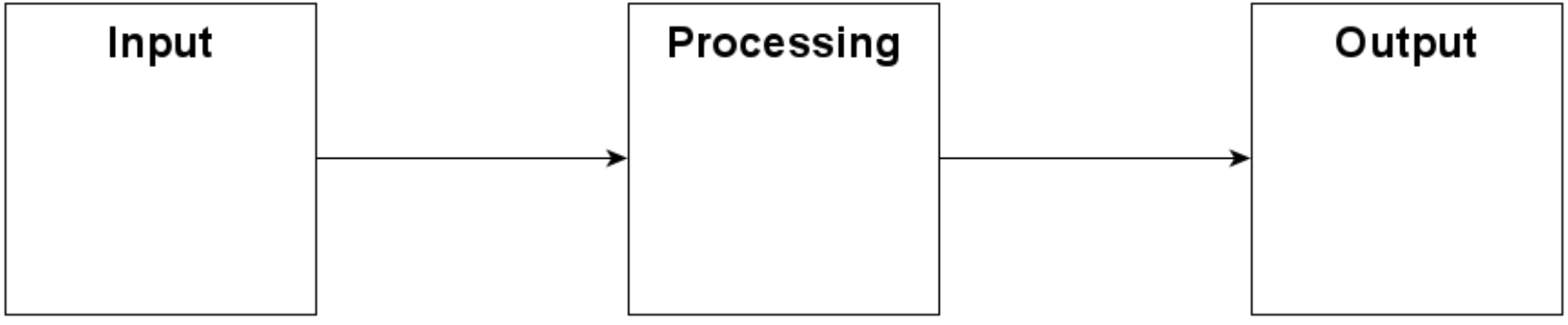
- So far we have learned about agents



- But let us tonight shift our focus away from the agent program, and towards the sensors and actuators

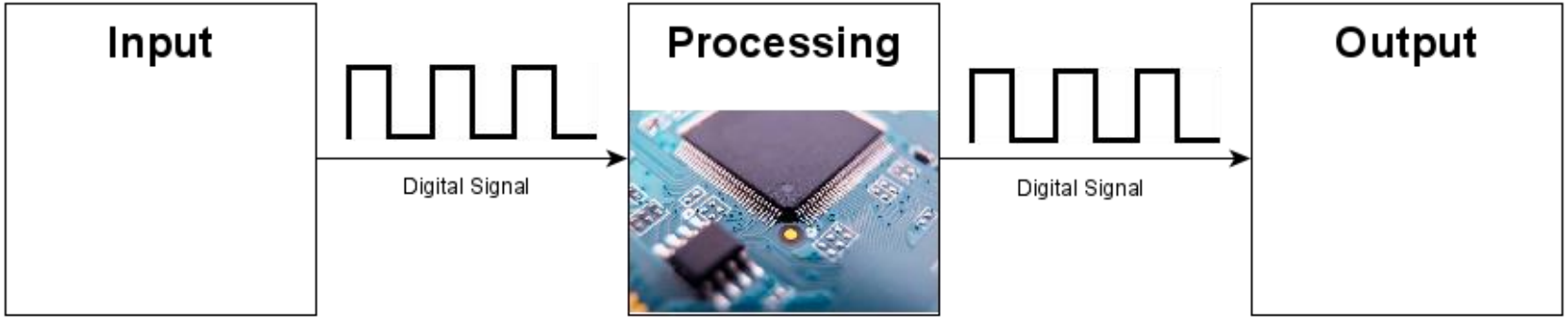
Abstraction

- We can also consider a system in a similar way, and in your previous courses you will have learned about the IPO model of systems:



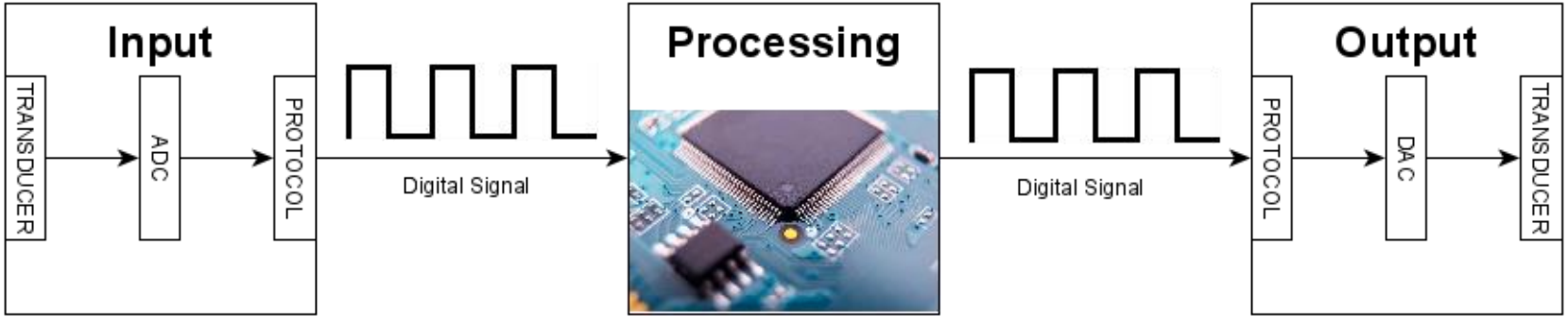
Abstraction

- We can also consider a system in a similar way, and in your previous courses you will have learned about the IPO model of systems:



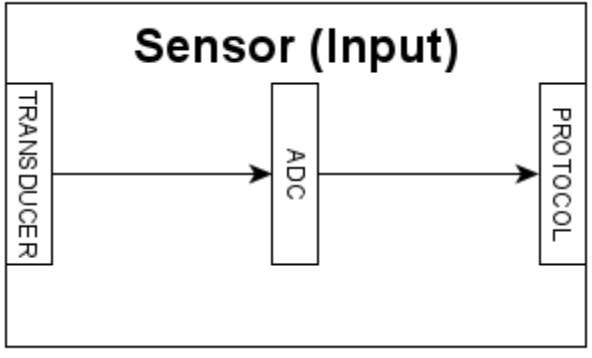
Abstraction

- We can also consider a system in a similar way, and in your previous courses you will have learned about the IPO model of systems:



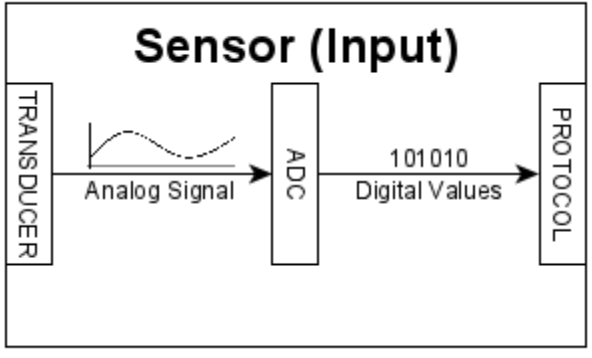
Sensors

- Focusing on the input stage, we consider sensors more generally…



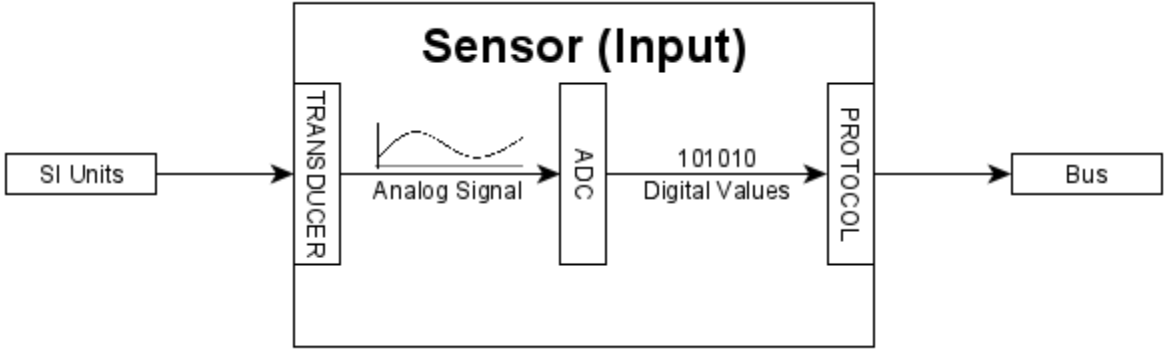
Sensors

- Transducers convert one form of energy into another
- Analog to Digital Converters convert analog signals to digital values



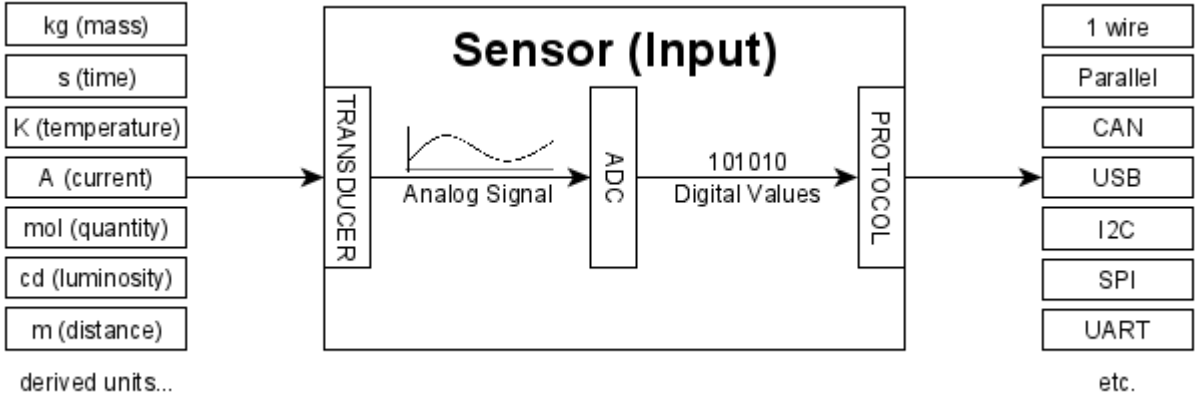
Sensors

- The physical things we can measure are generally described by the standard SI units
- The output from the sensor goes through a bus to the processor



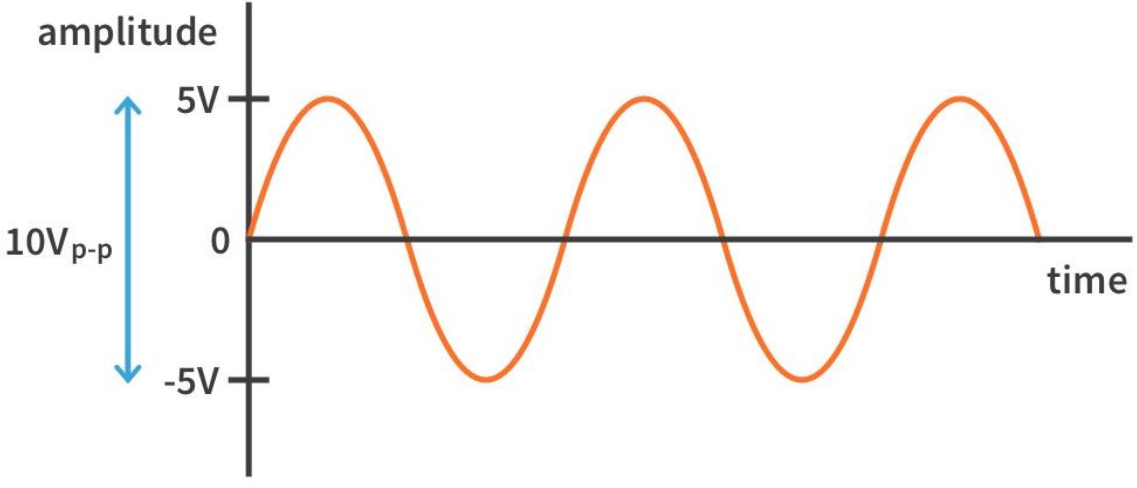
Sensors

- There are 7 basic SI units that describe physical measurements and a number of derived units
- A variety of busses exist to communicate with processors…



Analog signals

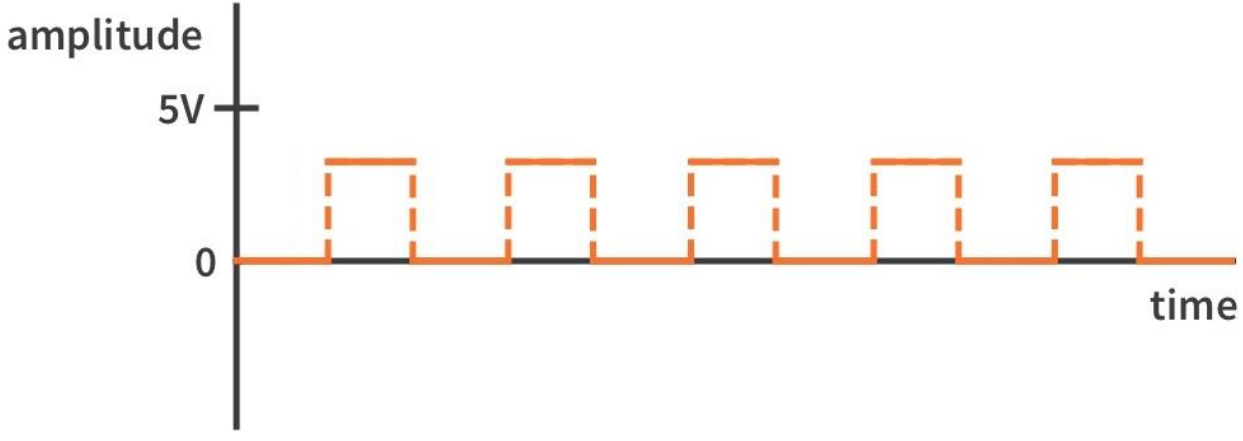
- Generally when we discuss analog signals we are talking about the voltage difference that we measure due to the flow of current.



Retrieved from [3]

Digital signals

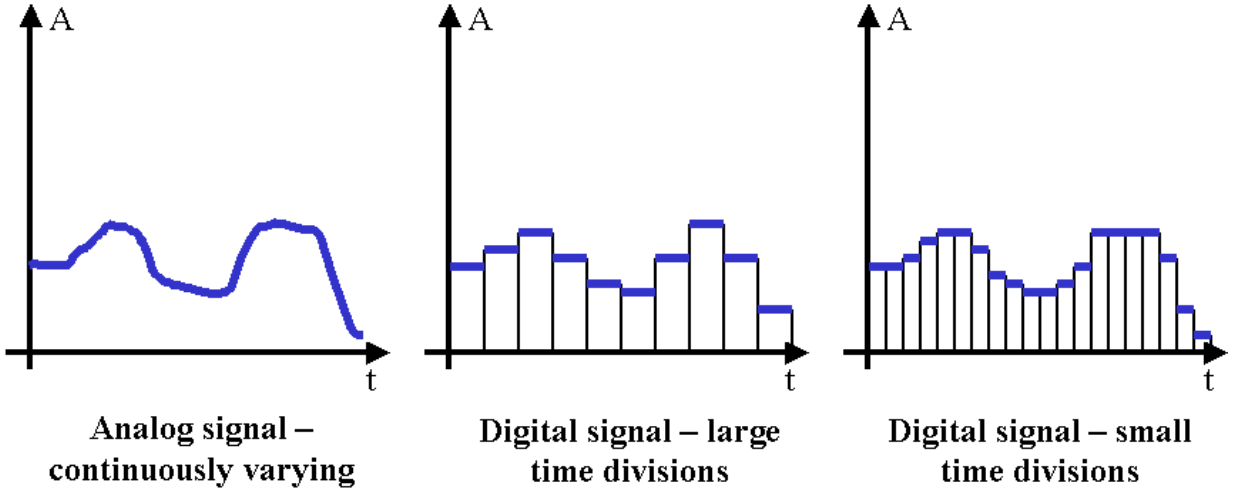
- Digital signals are also analog signals, but we only consider them above and below a certain threshold to represent logical values



Retrieved from [3]

Analog to Digital Conversion

- By taking very quick measurements of analog signals, we can convert them into digital values



Analog signal – continuously varying

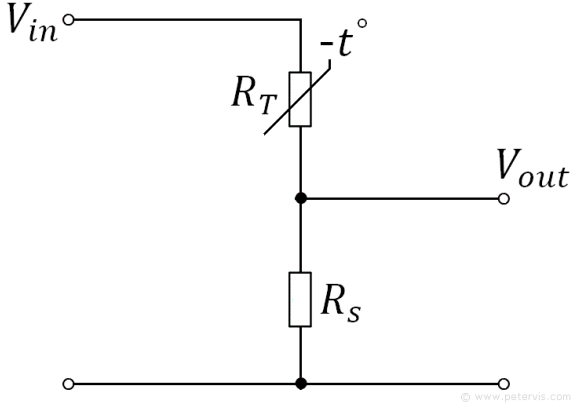
Digital signal – large time divisions

Digital signal – small time divisions

Retrieved from [5]

Let us consider an example

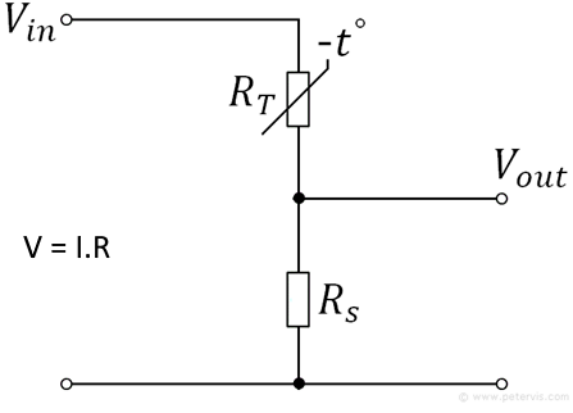
- A thermistor is a component that changes its resistance based on the temperature.



Retrieved from [6]

Let us consider an example

- The voltage across a resistor is directly proportional to the current flowing through it. We call this OHM'S LAW.

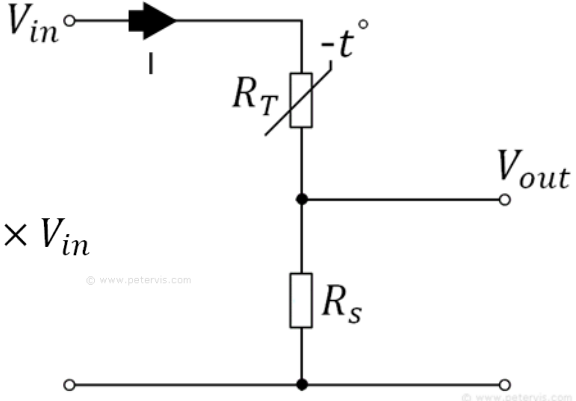


Retrieved from [6]

Let us consider an example

- We use the resistor divider formula to calculate the value of Vout.

$$V_{out} = \frac{R_s}{R_s + R_T} \times V_{in}$$

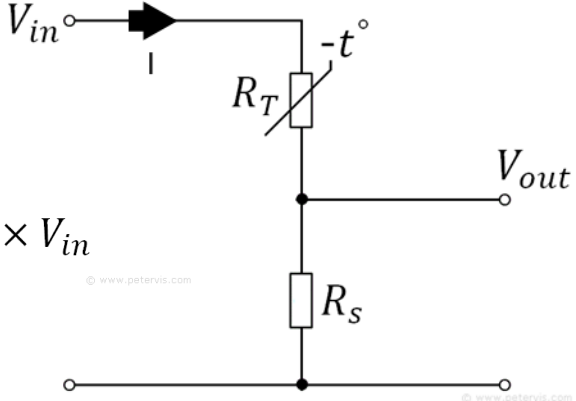


Retrieved from [6]

Let us consider an example

- The value of R_T changes as the temperature changes, changing the current flow through R_S which in turn causes an analog signal that can be measured at V_{out}

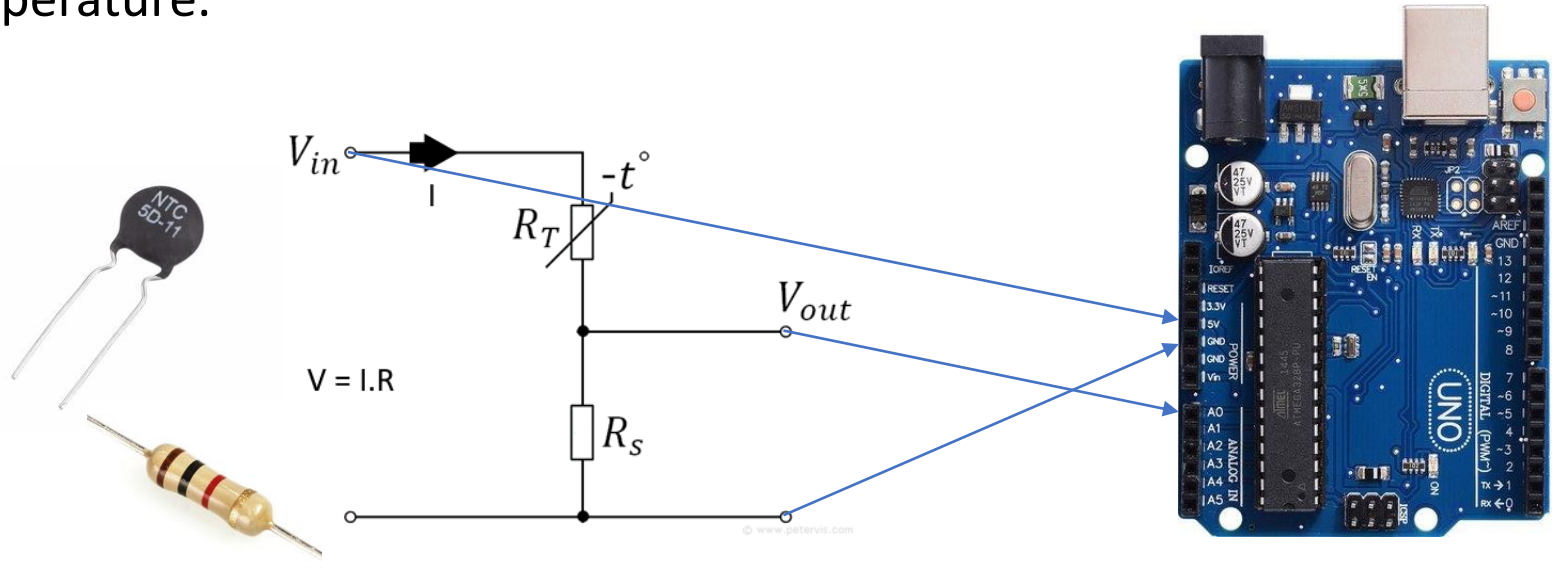
$$V_{out} = \frac{R_s}{R_s + R_T} \times V_{in}$$



Retrieved from [6]

Let us consider an example

- Wiring this circuit on to an Arduino will allow us to use the on board ADC to measure V_{out} which will give us an indication of the temperature.



Retrieved from [6]

But wait…

- I said that the sensor unit normally includes the ADC as well as an output that is sent to the processor via a bus – why would we go through all that effort if there is an ADC on the Arduino already?

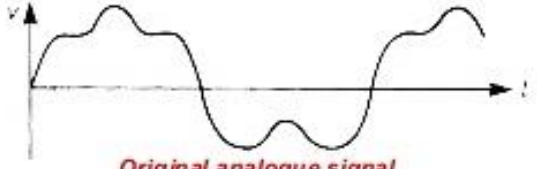
But wait…

- I said that the sensor unit normally includes the ADC as well as an output that is sent to the processor via a bus – why would we go through all that effort if there is an ADC on the Arduino already?

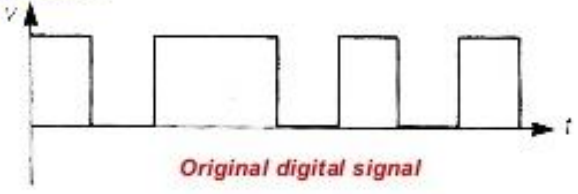
NOISE!

NOISE

Noise is always present within electronic systems and is due to fluctuations within the atomic structure of the components making up the system.



Original analogue signal



Original digital signal

Original analogue signal with noise

Original digital signal with noise

Noise is not related to the input signal

Retrieved from [7]

But wait…

- I said that the sensor unit normally includes the ADC as well as an output that is sent to the processor via a bus – why would we go through all that effort if there is an ADC on the Arduino already?

NOISE!

- By first converting the analog signal into a digital one, we can minimise the impact of noise on the analog representations of the physical things we are measuring. We want to keep this chain as short as possible – many times the measurement, ADC and bus output happen all on the same chip!

Sensors - temperature

MCP9808 High Accuracy I2C Temperature Sensor Breakout Board

Microchip TC77-5.0MCTTR, Temperature Sensor -55 to +125 °C ±3°C Serial-Microwire, Serial-SPI, 5-Pin SOT-23

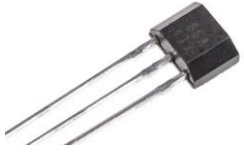
Texas Instruments LM35DZ/LFT1, Temperature Sensor -55 to +150 °C ±2°C Analogue, 3-Pin TO-92

RS PRO Thermistor 10Ω, 10 (Dia.) x 5mm

Retrieved from [8][9][10][11]

Sensors – other?

Luna Optoelectronics, 100 V Through Hole LDR (Light Dependent Resistor) 20 kΩ Light, 20MΩ Dark, 2-Pin TO-18 NSL-19M51



SS466A Honeywell, Hall Effect Sensors, 3-Pin

Parallax Inc 28015, PING))) Ultrasonic Distance Sensor Module

I.E.E. Strain Gauge 27.8mm, >1MΩ -30°C +170°C

Retrieved from [8][9][10][11]

Next week

- We continue with search algorithms.

- I hope you enjoyed this change to our regularly scheduled programming, and I hope I am getting you a little excited to try out some robotics as well!

References

[1]https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/

[2]https://www.youtube.com/watch?v=tpIctyqH29Q&list=PL8dPuuaLjXtNlUrzyH5r6jN9ulIgZBpdo

[3]https://www.circuitbread.com/ee-faq/analog-versus-digital-signal-processing

[4]https://smesouthafrica.co.za/investors-invest-south-africa-startups/

[5]https://www.rpi.edu/dept/phys/ScIT/InformationTransfer/sigtransfer/signalcharacteristics.html

[6]https://www.petervis.com/electronics%20guides/calculators/thermistor/thermistor.html

[7]https://www.slideshare.net/sld1950/electronics-noise

References

[8] https://za.rs-online.com RS stock #: 768-1549

[9] https://za.rs-online.com RS stock #: 121-9338

[10] https://za.rs-online.com RS stock #: 516-7805

[11] https://www.adafruit.com/product/1782

[12] https://za.rs-online.com RS stock #: 914-6710

[13] https://za.rs-online.com RS stock #: 169-7663

[14] https://za.rs-online.com RS stock #: 781-3020

[15] https://za.rs-online.com RS stock #: 189-5590